LLNL-PRES-542311

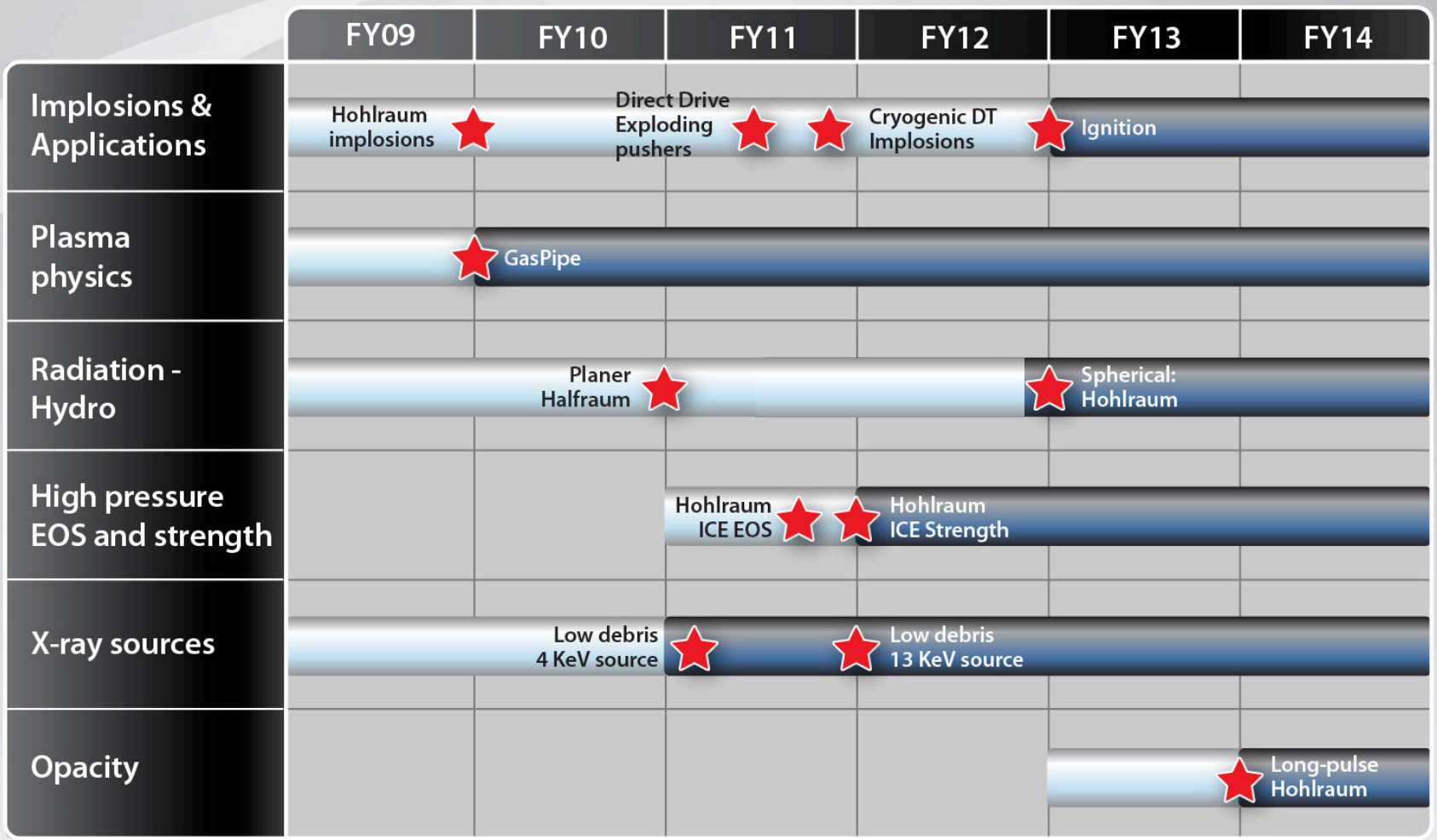
Experimental Platforms on NIF

Warren Hsing

Presentation to: User Science Workshop on NIF

February 14, 2012

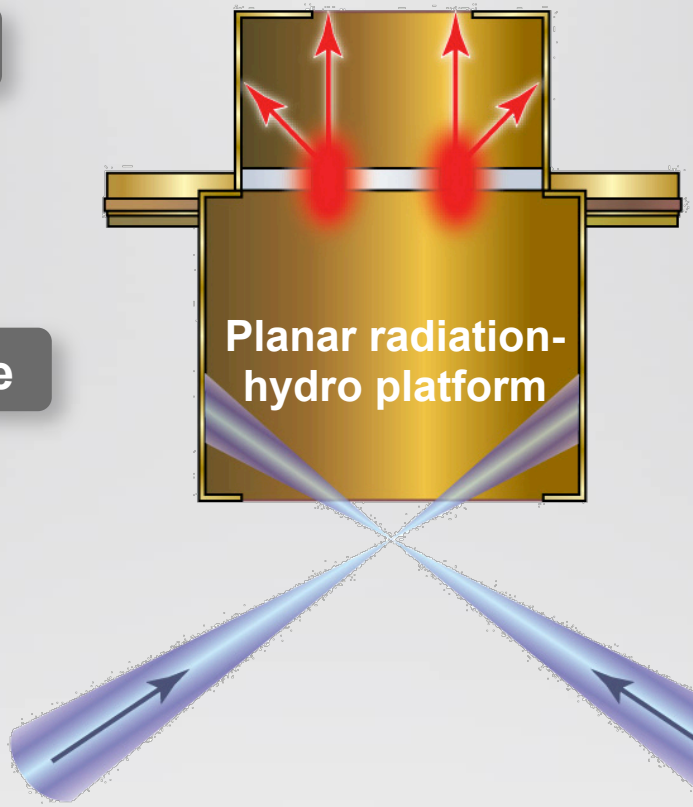
We will commission new experimental platforms that can be applied to science experiments



An integrated suite of capabilities to perform an experiment is termed the experimental "platform"

Targets

Diagnostics



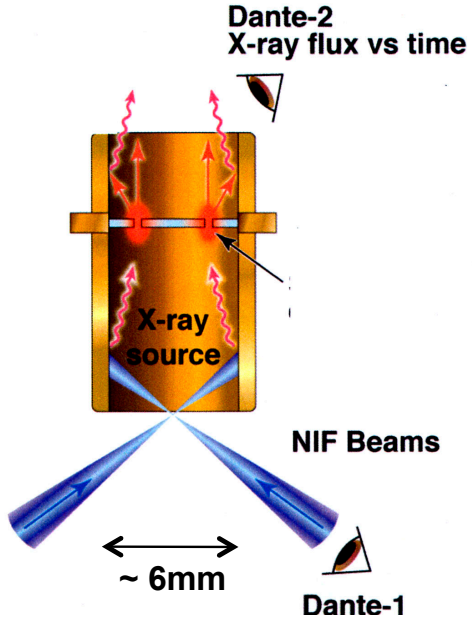
Hohlraum drive

Data Analysis

Multiple configurations are sometimes needed to address specific physics issues

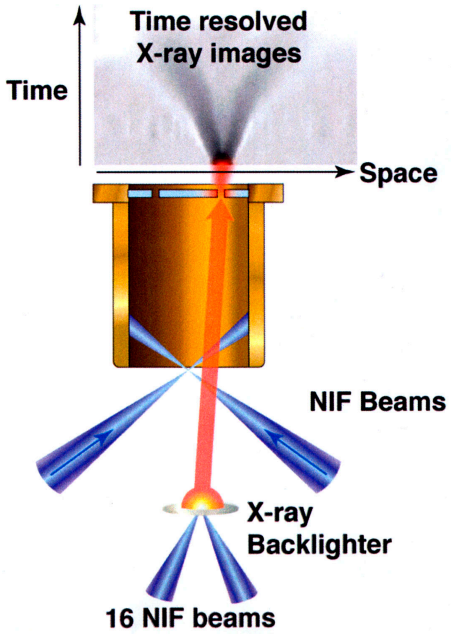
Radiation-hydro platform

Calorimetry configuration



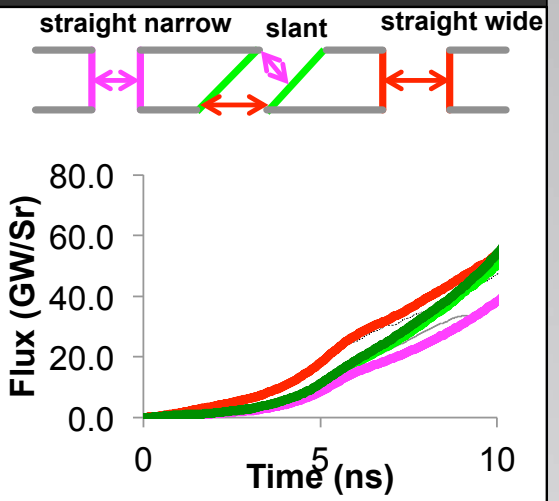
Tr = 200 eV, 10 nsec

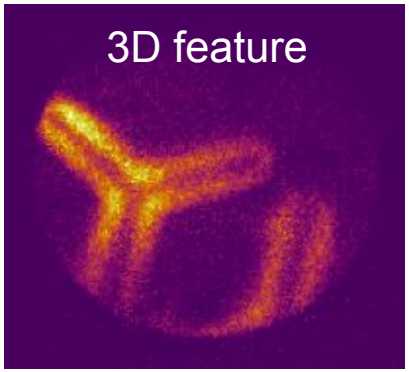
Radiography configuration



8 keV, 8 nsec point backlighter

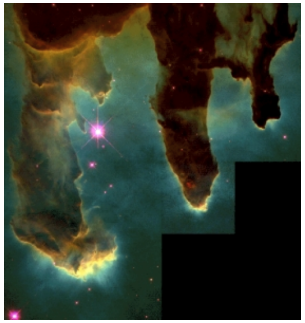
Streaked and gated

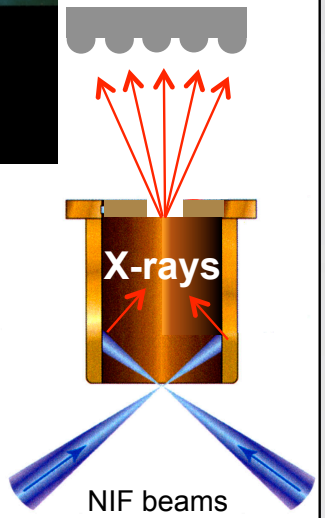




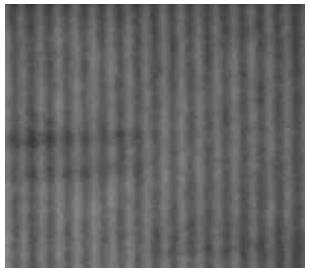
Once developed, an experimental platform can be customized and applied across a wide variety of physics experiments

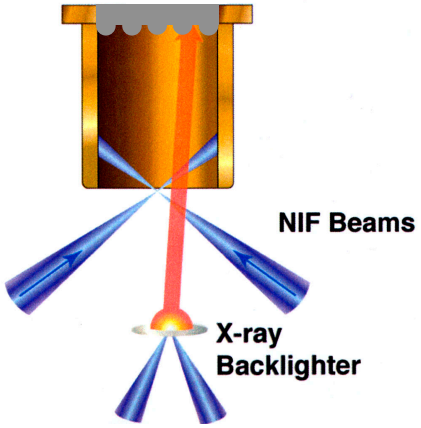
Formation of the Eagle Nebula Pillars



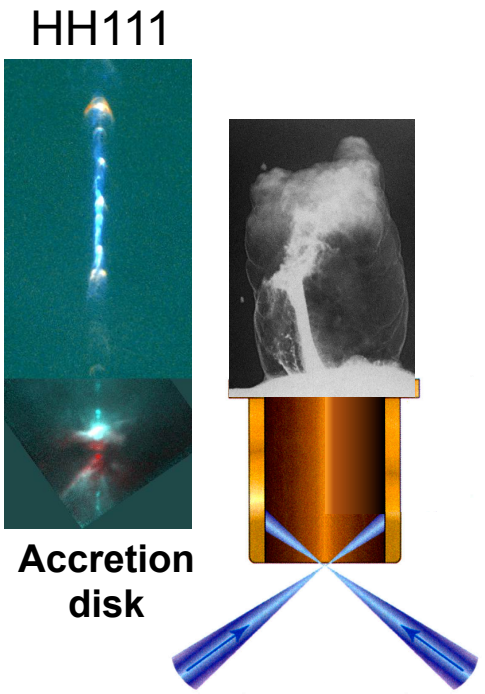


Non-linear ablation front hydrodynamics





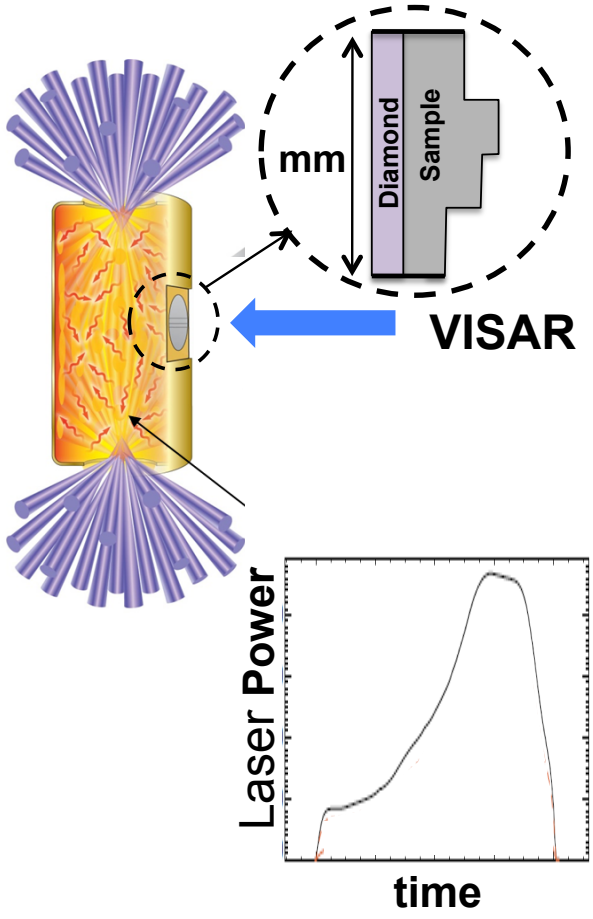
Formation of Herbig-Haro jets



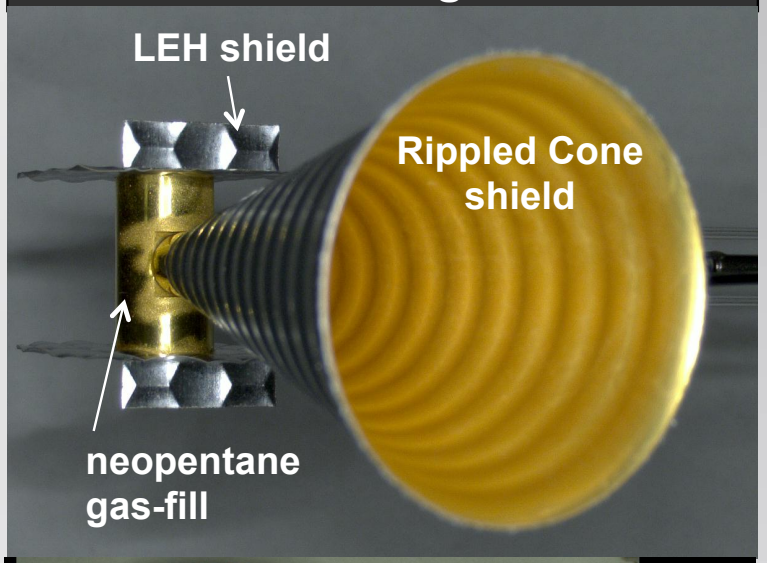
These experiments can utilize a modified planar-radiation hydrodynamics platform

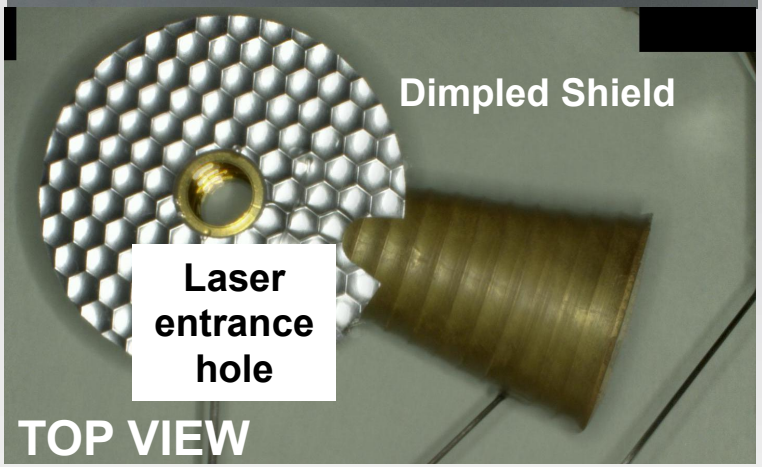
Turning a concept into a practical experiment requires a suite of capabilities and integrated knowledge of the facility

EOS concept



EOS target



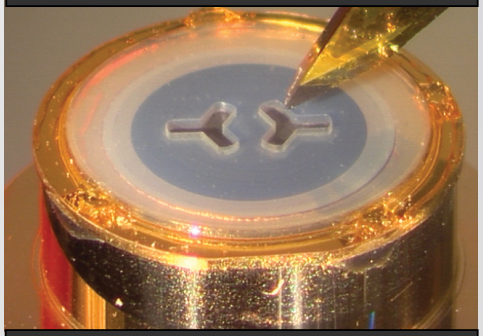


NIF personnel have been identified to work with the current proposals to implement the experiments

Target capabilities

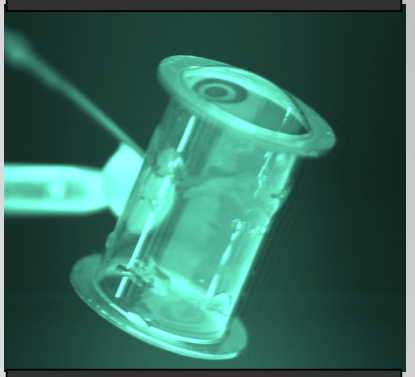
- Material synthesis
- Capsules
- Micromachining
- Gas fill
- Characterization
- Cryogenics
- Assembly
- Alignment & target fiducials
- Unconverted light & shields
- Debris
- Materials restrictions

Foam synthesis & micromachining



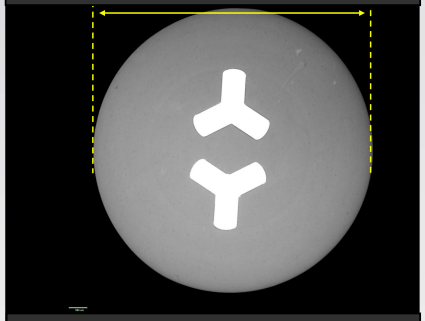
Low-Z, high-Z and pure metal foams can be synthesized

Gas Fill



Gas pipes, hohlraums & capsules

Characterization



X-ray radiographs

Cryogenics, Unconverted light shields, Assembly

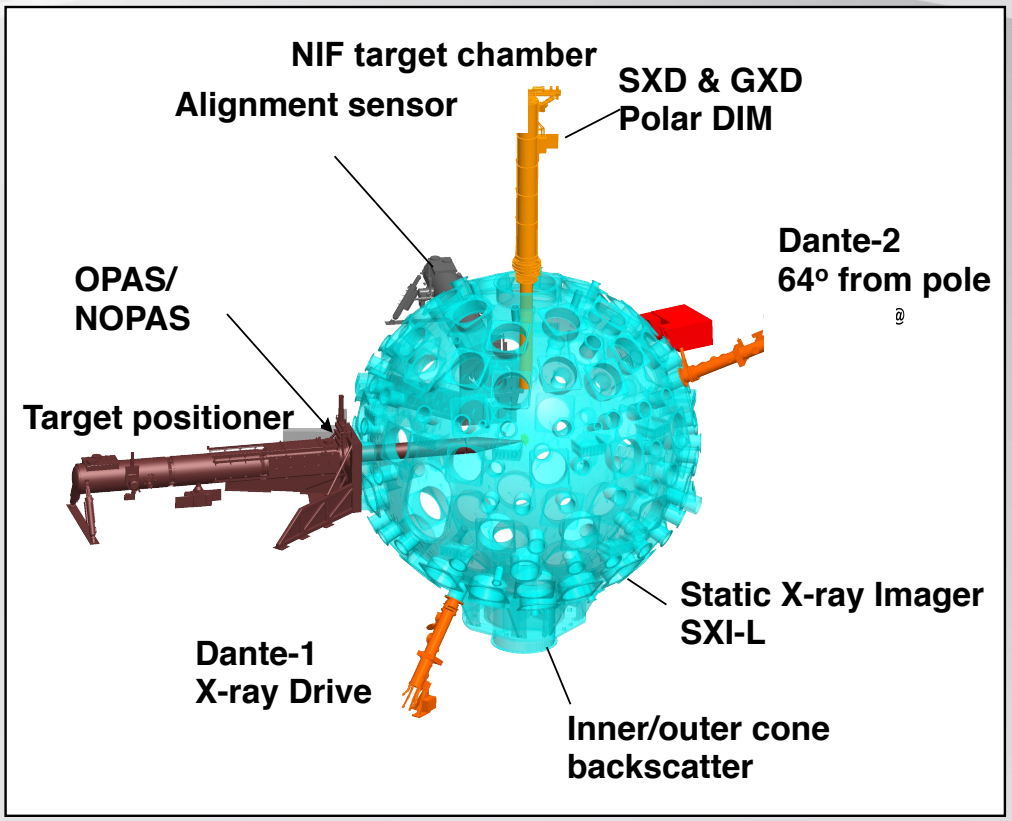
Shock Timing Configuration

Cryo Thermo-Mechanical Package

NIF personnel have been identified to work with the current proposals to implement the experiments

Diagnostic capabilities

- Modifications / new design design, build, qualify
- Lines-of-sight
- Detector configuration
- Filters
- X-ray backlighters
- Debris and damage
- Alignment
- Calibration
- Cross-timing
- Materials compatibility
- Unconverted / scattered light
- Activation / contamination



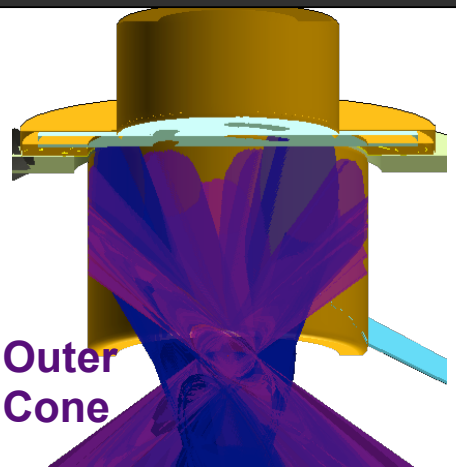
- X-ray diagnostics
  - — Time-resolved, time-integrated detectors, imaging & spectral snouts
  - — Soft x-ray flux
- Optical diagnostics (Backscatter, VISAR)
- Nuclear diagnostics (nToF, activation, MRS, NI, WRF, Gamma BT, Radchem)

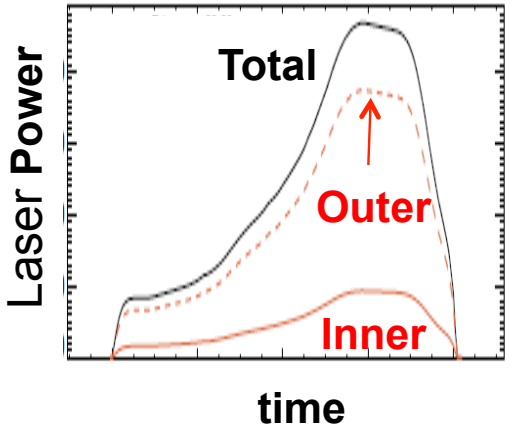
NIF personnel have been identified to work with the current proposals to implement the experiments

Laser drive capabilities

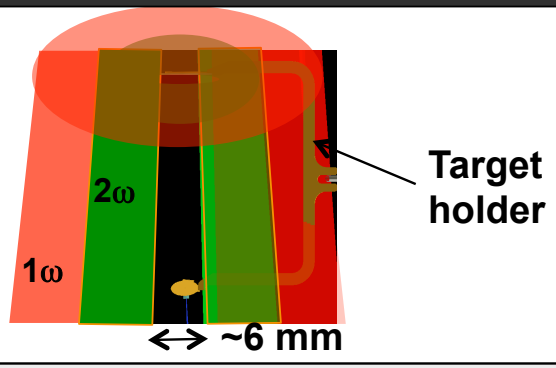
- Hohlraum vs direct drive
- Pulse shape
- Beam pointing and focus
- Beam smoothing
- Wavelength separation
- Drive characterization
- Drive symmetry
- Backscatter & hot electrons
- Unconverted & counter-propagating light
- Optics lifetime

Beam pointing, focus, pulse shape

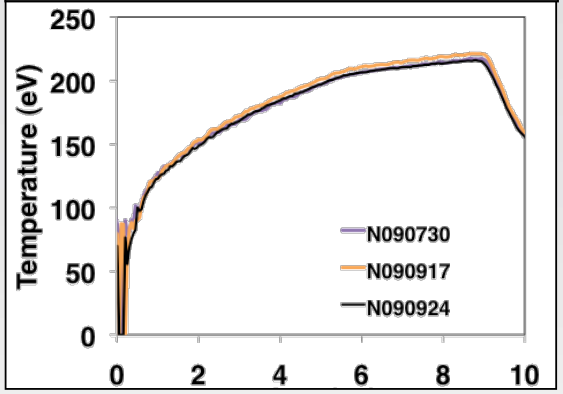




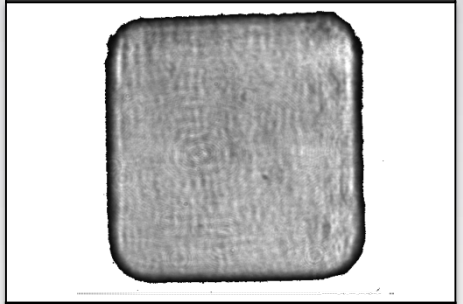
1ω, 2ω unconverted light



Drive Temperature



Beam smoothing



CPPs, polarization, SSD bandwidth

NIF personnel have been identified to work with the current proposals to implement the experiments

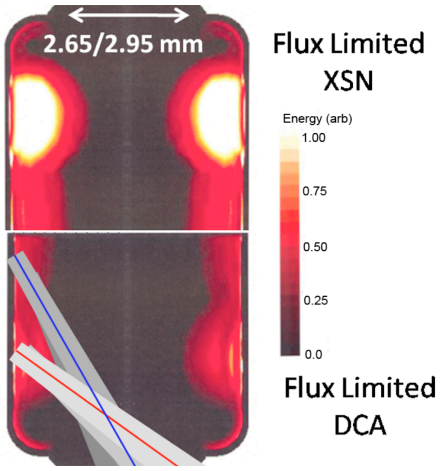
Simulations

- Hohlraum / direct drive designs
- Backscatter assessment
- Preheat assessment
- Material database
- X-ray backlighter designs
- Debris, EMP

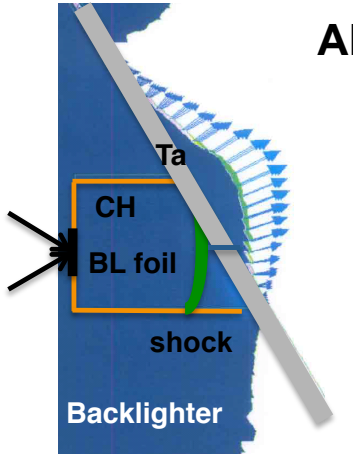
Data Analysis

- Instrument correction
- Data unfold routines
- Film/image plate scanning
- Data archival
- Data access

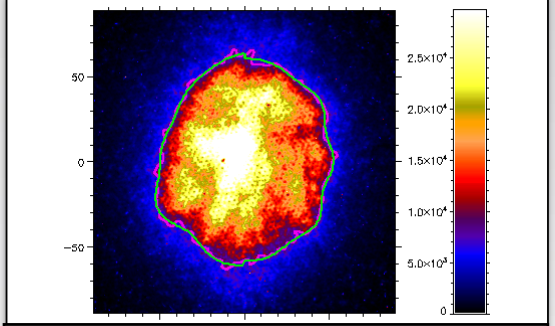
Hohlraums



Backlighter debris



Instrument correction



Timing, exposure, flat field, linearity, magnification, resolution, energy band

It is beneficial to use existing platforms when applicable

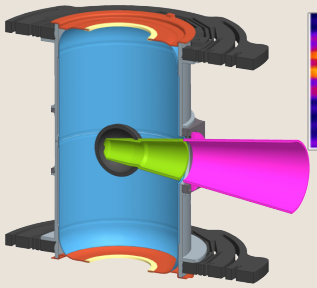
Typical lead times prior to a NIF experiment			
Capability	**Identical to existing platform**	**Small modification to existing platform**	**New capability**
Targets	**1 – 6 months**	**6 months – 1 year**	**> 1 year**
Laser drive	**~ 1 month**	**1 – 6 months**	**> 6 months**
Diagnostics	**~ 1 – 3 months**	**3 – 6 months**	**> 6 months**
Data analysis	**Exists**	**1 – 3 months**	**> 3 months**

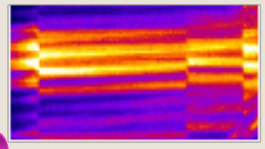
Identification of key scientific experiments can drive new capabilities required

The National Ignition Campaign uses 4 main platforms

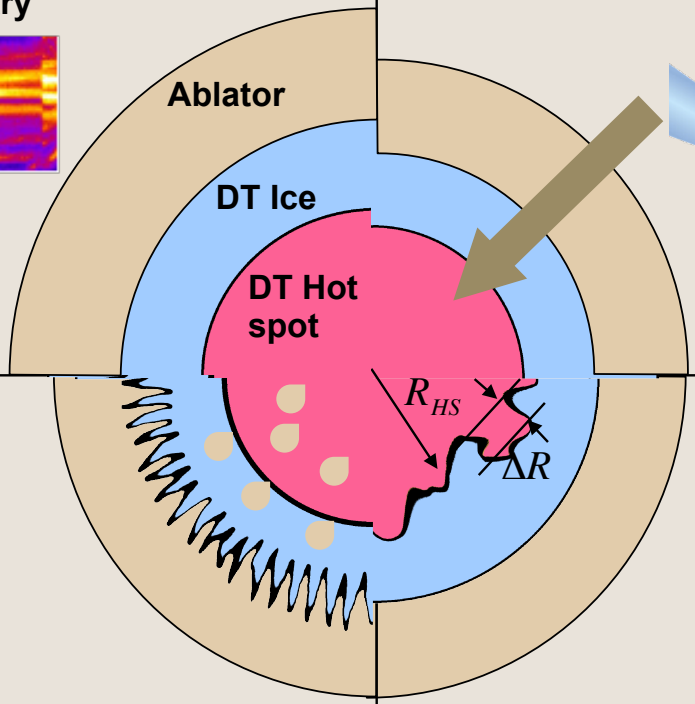
α Adiabat

VISAR interferometry



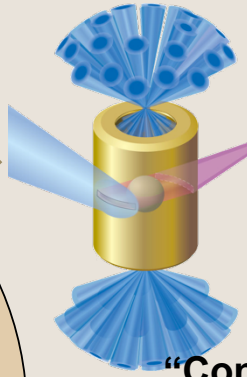


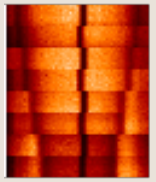
"Keyhole"



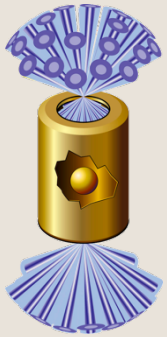
Velocity V

X-ray Backlit Shell Trajectory

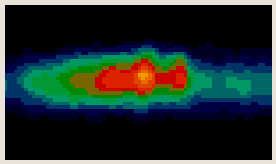




"Convergent Ablator"

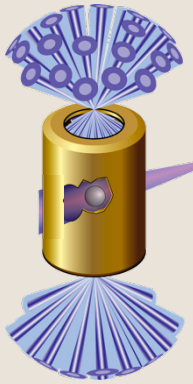


Ge Spectra



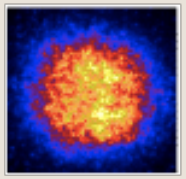
M Mix

"THD/DT"



"Symcap"

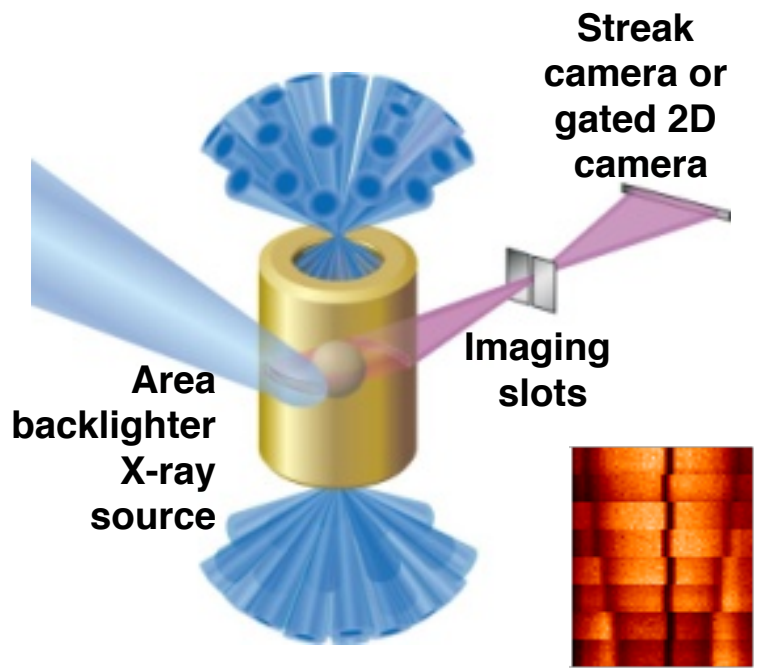
X-ray or neutron core image



Shape S

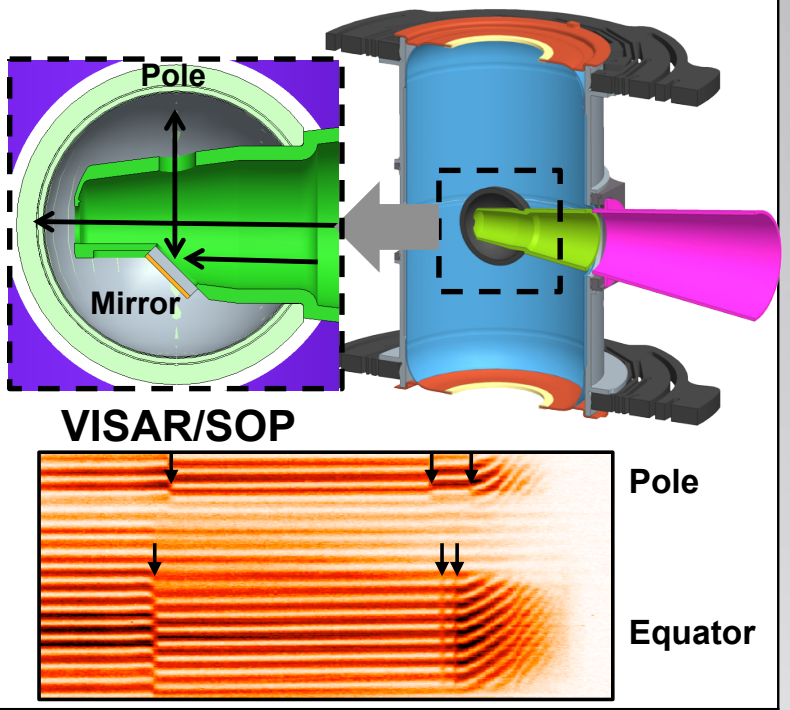
NIC platforms can be applied to fundamental science

Convergent Ablator Platform



Potential applications:
Gbar EOS, convergent hydrodynamics (RT,RM,KH)

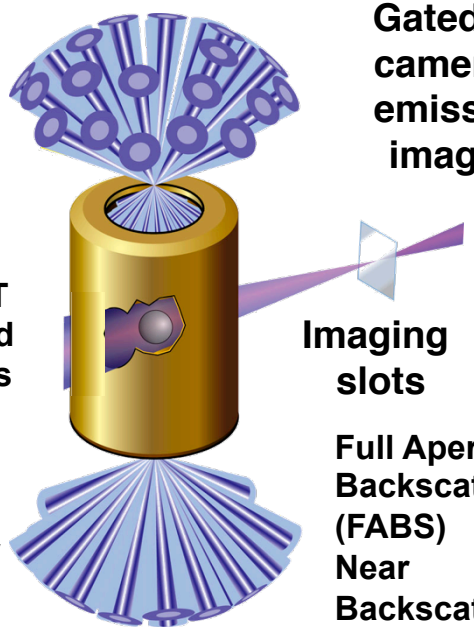
Keyhole Platform



Potential applications:
Convergent shock physics, RM instability

NIC platforms can be applied to fundamental science

Symcap Platform



Gated 2D camera – emission imaging

D2 or DT gas filled capsules

Imaging slots

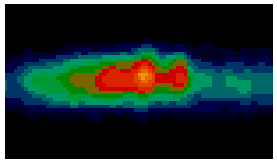
Full Aperture Backscatter (FABS)
Near Backscatter Imaging (NBI)

Soft X-ray emission (DANTE)

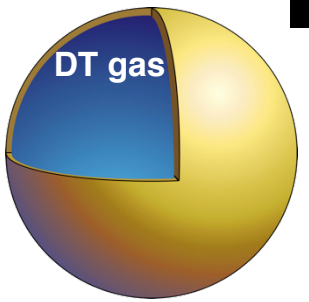
Potential applications:
Hohlraum energetics/Laser Plasma Instabilities, drive characterization for experiments,

Exploding Pusher Platform

Neutron time-of-flight
Gaseous radchem
Solid radchem
Yield



spectroscopy

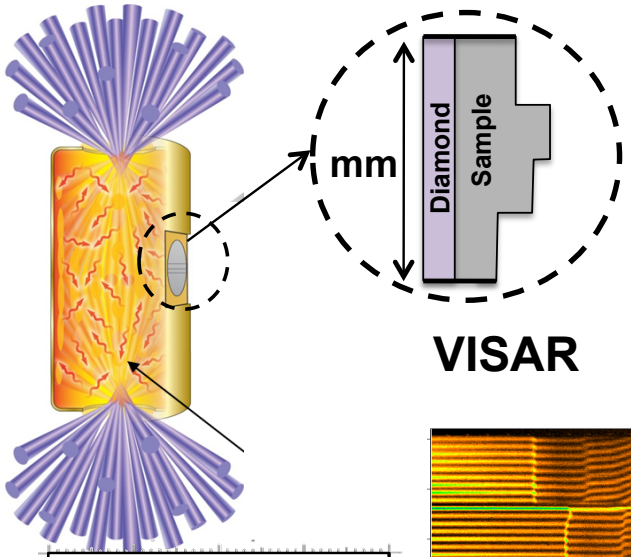


SiO2 or CH shell
+ gas dopants
+ shell dopants

Potential applications:
NLTE atomic physics, spectroscopy, nuclear physics w/ radchem

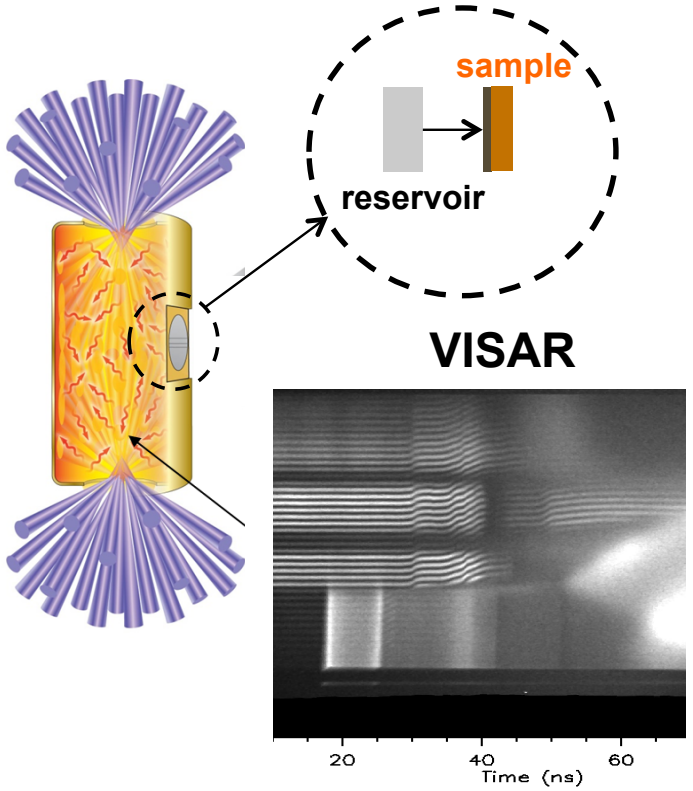
Planar X-ray driven platforms can reach 10's of Mbars pressure quasi-isentropically or 100's Mbars Hugoniot

EOS



Drive generated by pulse shaping

Material strength

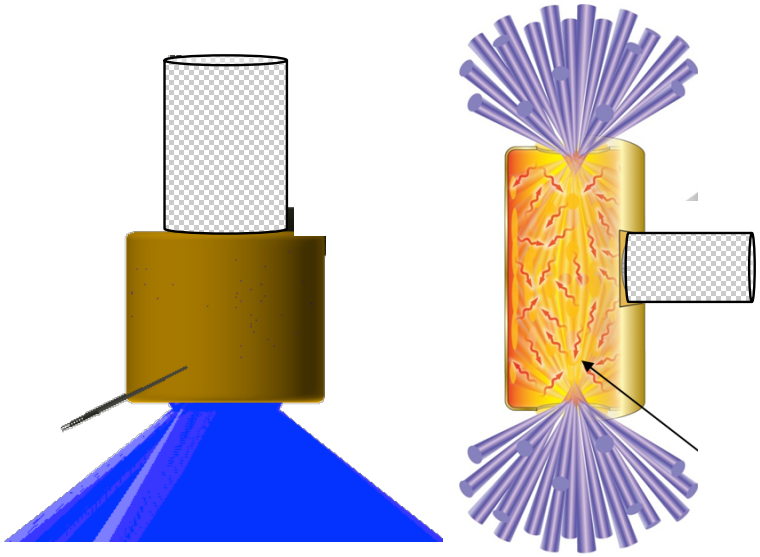


4 Mbars achieved in Ta

Quasi-isentropic drive generated by material pressure

Existing platforms continually evolve

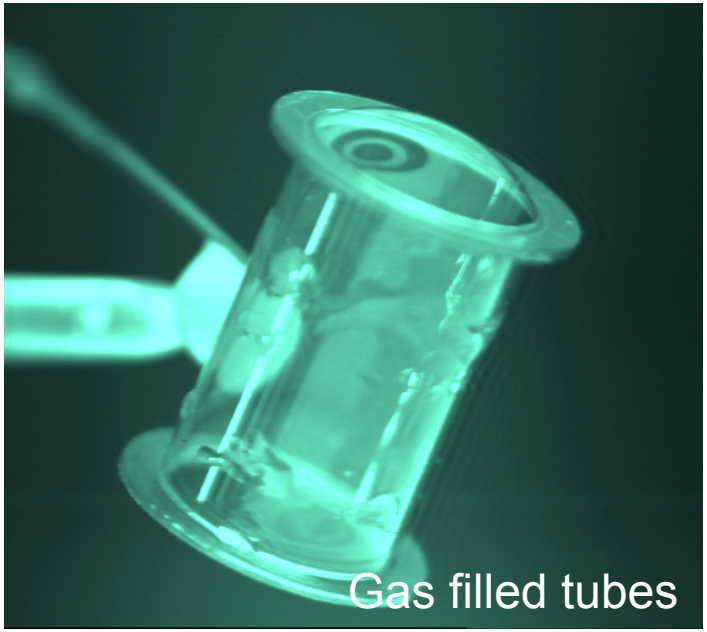
Planar Hydrodynamics Platforms now achieve >300 eV drive



Vacuum Half hohlraum 350 eV

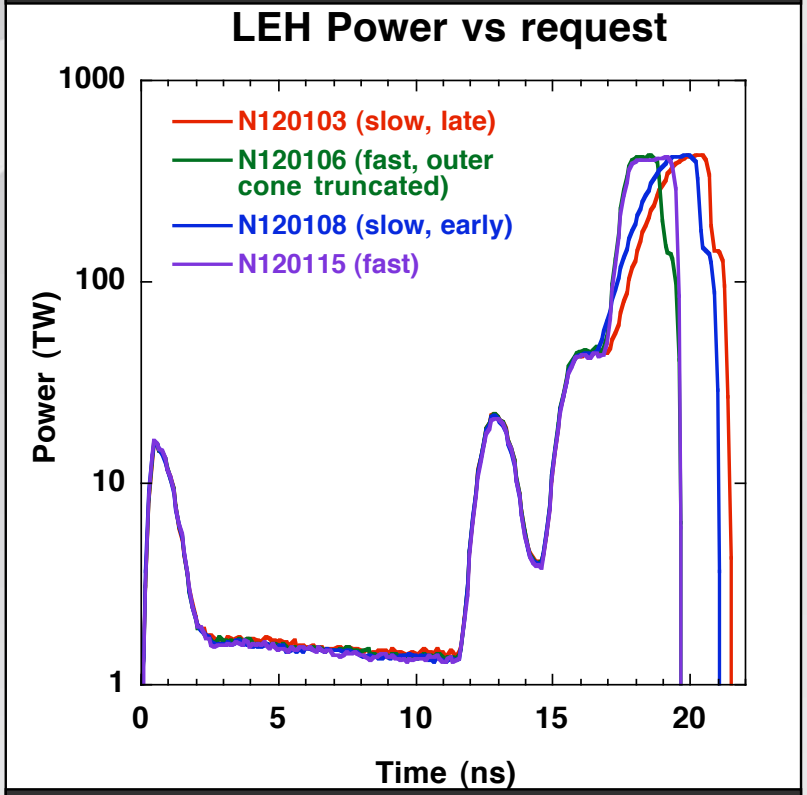
Gas filled hohlraum >300 eV

X-ray sources will use Fe foam filled tubes and Kr gas fill



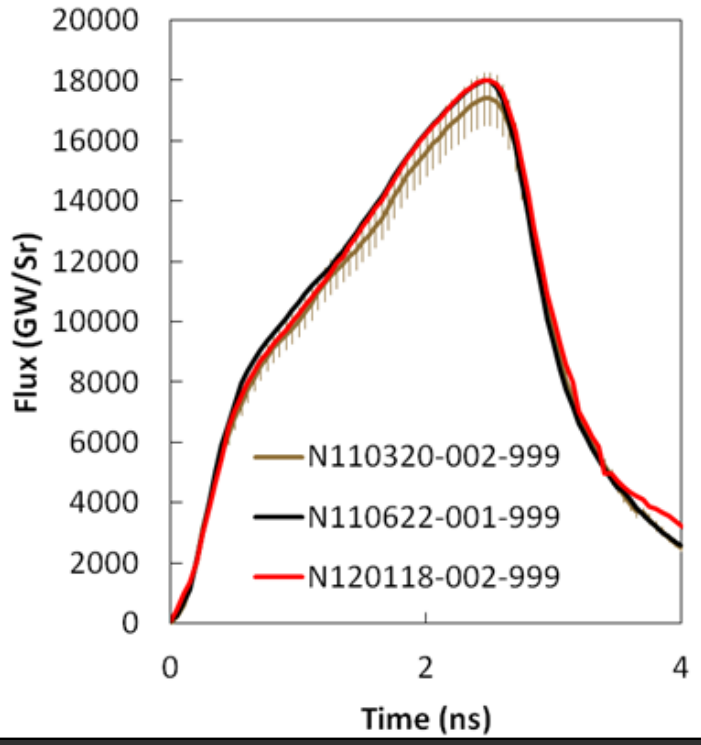
Experiments have demonstrated a high degree of reproducibility in the laser and X-ray drive

Laser energy vs request is typically within ~ 3%



Example of pulse shape changes during a NIC campaign

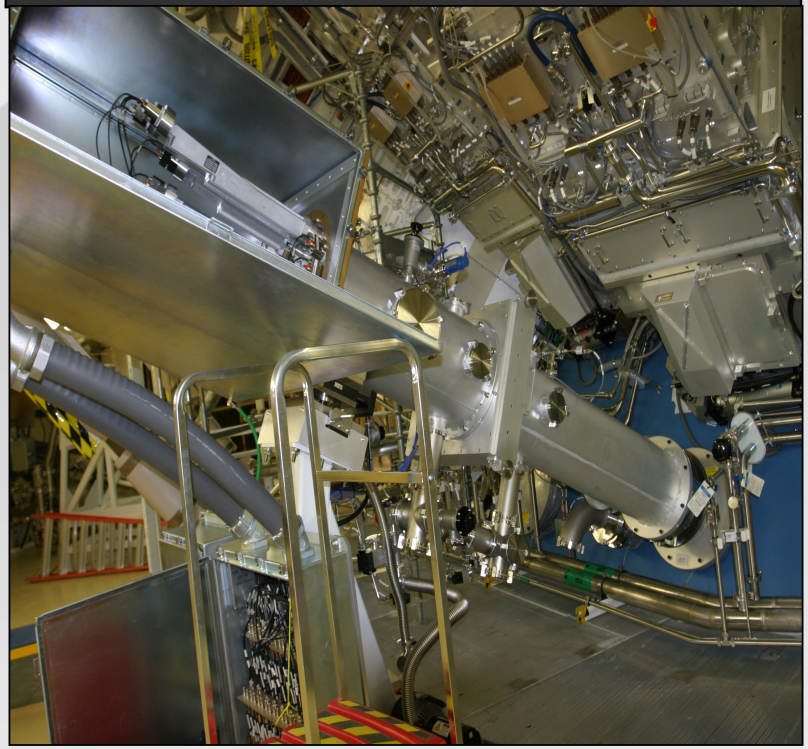
Reproducibility in X-ray flux was measured to be ~ 5%



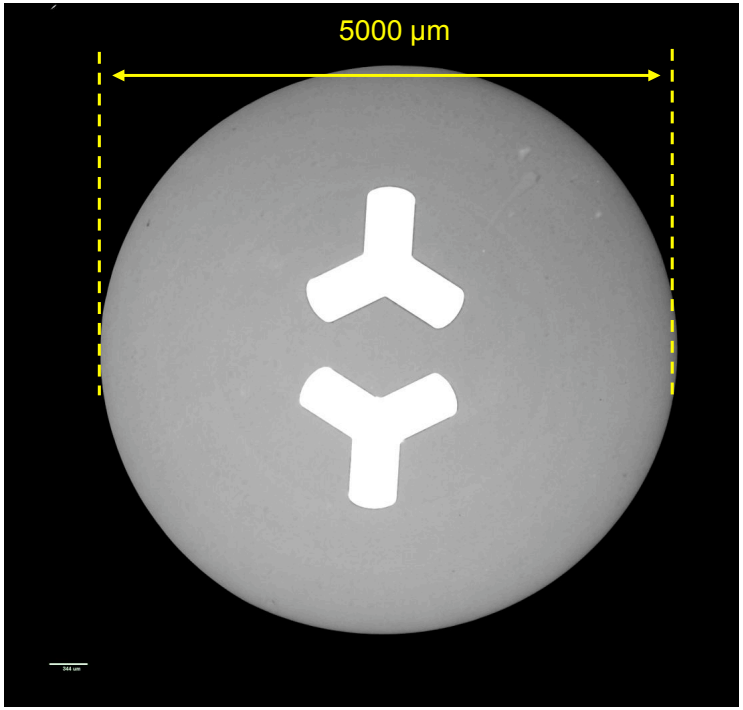
Example of measurements taken on 3 shots over a 9 month period

Diagnostics and targets are calibrated or metrologized to a high level of accuracy

DANTE has ~ 5000 calibrations taken to provide x-ray flux with an absolute accuracy of ~ 7%



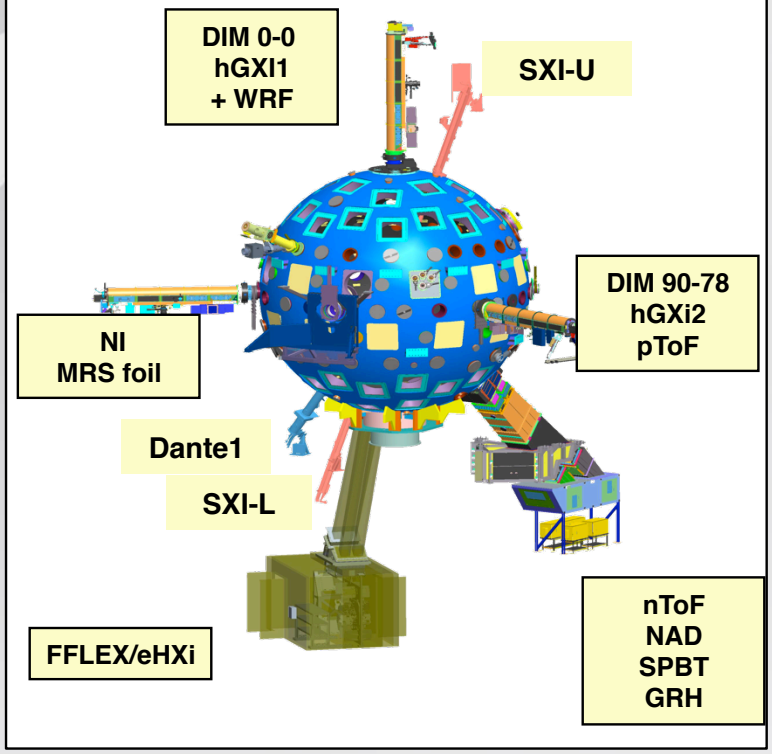
X-ray radiographs measure uniformity and density-length of completed target to ~ 3%



Together with the laser, allows highly precise measurements to be taken on NIF

We enhance shot opportunities on NIF by minimizing changes in facility configurations

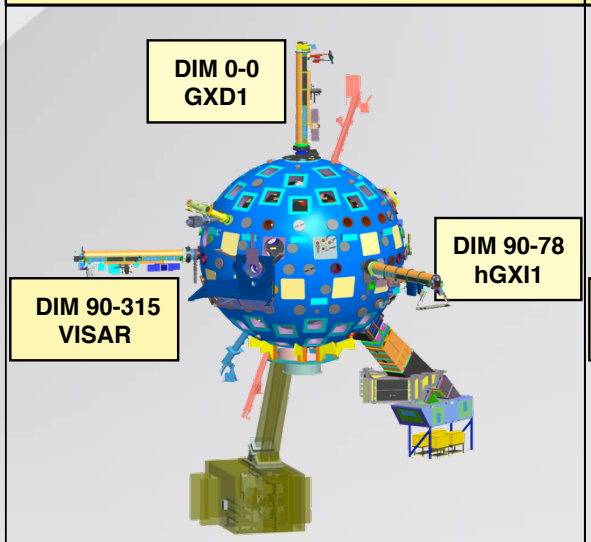
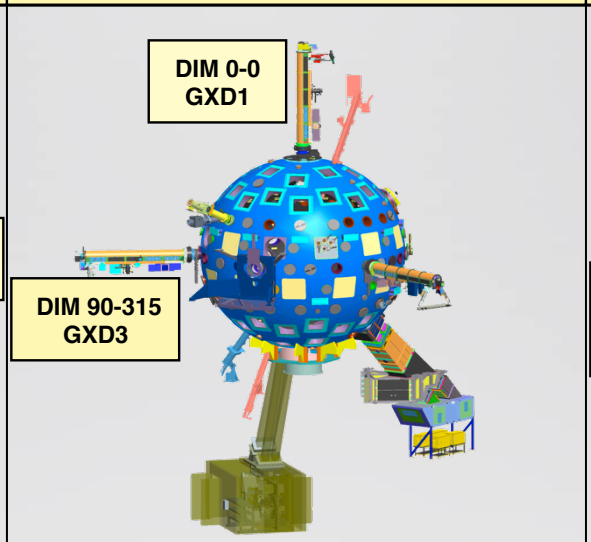
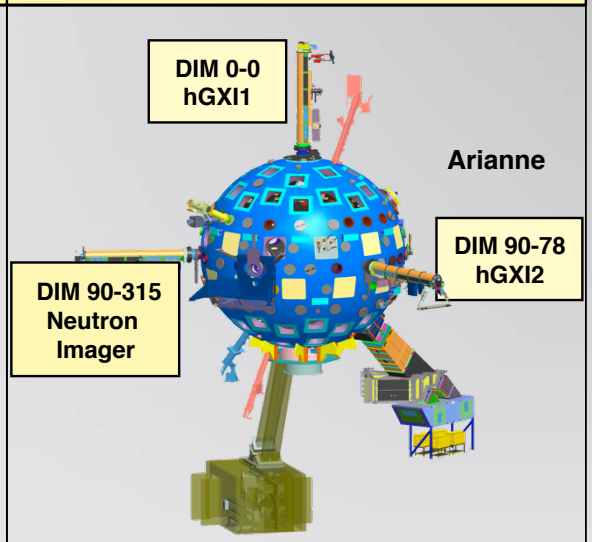
Diagnostic Configuration: 3
Yield w/neutron imaging



- A facility configuration is defined to a set of diagnostics, optics, classification and yield configurations that require multiple shifts to change
- Examples of capabilities that require multiple shifts to reconfigure
  - Exchanging instruments in a DIM
  - Yield Experiment > 1e14
  - >8 CPPs exchanged
  - Classified diagnostics
  - Special diagnostic reconfigurations
- Examples of capabilities that can be modified during the shot cycle
  - Imaging front end for a gated imager
  - Attenuators and filters on DANTE
  - Sweep speed and timing for a gated instrument
  - These do not define unique configurations

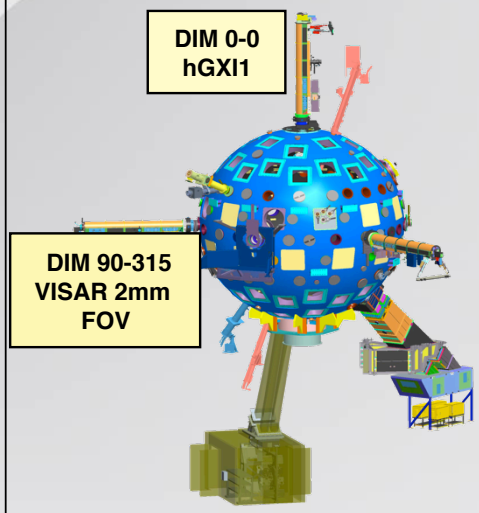
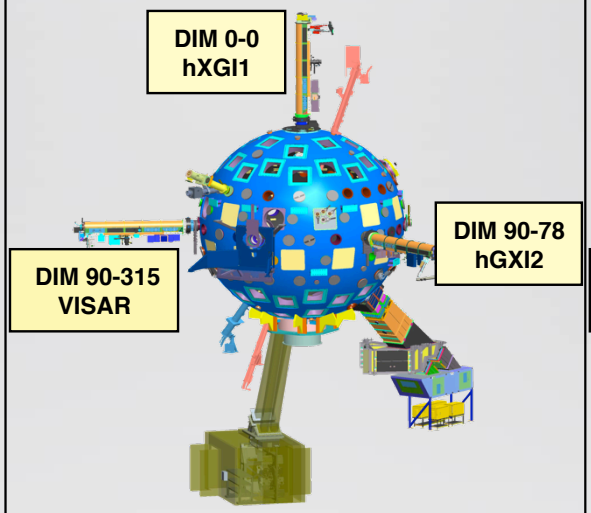
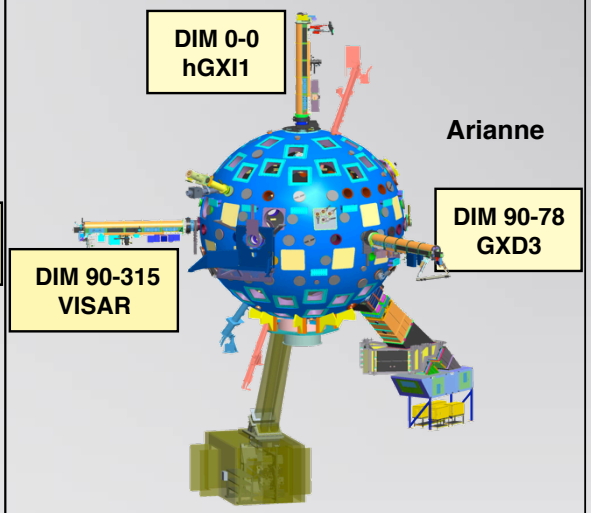
The integrated NIF plan is based on a minimal set of configurations that both meet user needs and optimize facility availability

Configurations	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept
	1	2 3 4	5 3 6	3		5	3	7	6

Diagnostic Configuration 1: Compton Radiography	Diagnostic Configuration 2: Conv ablator 90-315	Diagnostic Configuration 3: DT w/neutron imager
		
Compatible with: Symcap, keyhole, EOS, EP, DIME, Pleiades, Fanbolt, viewfactor, Abl RT, EPEC-A	**Compatible with:** EP, Fanbolt, Abl RT, XRSA, EPEC-A; Alternate config for Symcap, DIME	**Compatible with:** Symcap, EP, THD, DIME, Mix symcap, Pleiades, Fanbolt, Abl RT, XRSA, EPEC-A

The integrated NIF plan is based on a minimal set of configurations that both meet user needs and optimize facility availability

Configurations	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept
	1	2 3	4 5	3	6	3	5	3	7 6

Diagnostic Configuration 4: HED EOS	Diagnostic Configuration 5: Largest number of platforms	Diagnostic Configuration 6: Conv Abl 90-78
		
Compatible with: Matl Strength Drive	**Compatible with:** Symcap, Keyhole, EP, DT w/o NI, DIME, Pleiades, Fanbolt, Viewfactor, EOS, Abl RT, XRSA, EPEC-A, Mix Symcap	**Compatible with:** Symcap, Keyhole, EP, DIME, Pleiades, Fanbolt, Mix sym, Viewfactor, EOS, Gbar EOS, Abl RT, XRSA, EPEC-A

NIF is operational, conducting experiments and acquiring great data